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A MULTICENTER AND EPIDEMIOLOGICAL STUDY OF PATTERNS AND TREATMENT STRATEGIES FOR MANDIBULAR CONDYLE FRACTURES

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Abstract

To evaluate retrospectively the epidemiological characteristics of the prevalence, type and treatment modalities of the condylar mandibular fractures. Data of all patients who underwent surgical or nonsurgical management for condyle mandibular fracture were collected. The study was conducted to assess the trauma etiology, age group, gender, treatment method, anatomic distribution of injury and complications by reviewing patients' records. There were 139 patients with 171 mandibular condylar fractures. Among these patients, 85% were men, with an overall male-to-female ratio of 5.6:1. The highest occurrence of trauma was in the 21-30 years age group. The most frequently observed etiology was motorcycle traffic accidents and the subcondylar region was the most common location with 109 fractures. There was statistically significant difference between treatments ($p < 0,001$). In the nonsurgical treatment group, the prevalence of complications was observed compared to the surgical group ($p < 0.001$). The predominant complications were: mouth opening limitation, mandibular deviation, malocclusion, temporomandibular disorder, paresthesia and facial paralysis. Considering the limitations of this study, subcondylar fractures were the most frequent, especially in men aged 21-30 years, and the surgical treatment showed the fewest complications.

Keywords: Complications. Condylar fractures. Maxillofacial injuries. Treatment.

1. Introduction

Maxillofacial fractures are one of the most frequent traumas treated in a maxillofacial surgery department, representing a serious public health and economic problem (Liu et al. 2013; Bonavolonta et al. 2017). The condyle is the primary site of fracture for the mandibular bone in terms of prevalence (Monnazzi et al. 2017; Thapa et al. 2017) which is attributed to the high stiffness of the mandibular ramus and the low stiffness of the mandibular condylar head (Choi et al. 2012). Epidemiological surveys vary

according to research period, regional characteristics, and social conditions. These factors affect the etiology and may cause differences in the pattern and distribution of the fracture (Boffano et al. 2014).

The most common cause of the mandibular condyle fracture is road traffic accident (RTA). Moreover, studies show that interpersonal violence, assault, sporting accidents, falls from heights, and industrial accidents have a direct relation with this facial trauma (Rastogi et al. 2015; Silva et al. 2016).

Various classification systems have been developed and published, essentially since the development of treatment protocols for these injuries (Powers 2017). Thus, according to the affected anatomic region, it can be classified as condyle head, condyle neck or subcondylar (Neff et al. 2014). The classification is important to determine the form of therapeutic approach used and to standardize the clinical and radiographic findings (Chrcanovic 2015).

The management of mandibular condylar fractures is perhaps the most controversial topic in maxillofacial trauma (Ellis 2016). The treatment choice depends on fracture characteristics and imaging findings (Niezen et al. 2018), considering factors such as fracture type and level, condylar size and position, and degree of displacement. Additionally, the dental state, malocclusion and mandibular dysfunction, presence of foreign bodies and presence of concomitant mandibular or facial fractures play a role in clinical decisions. Finally, the experience of the surgeon and the willingness of the patient to undergo operation can determine the choice between surgical or nonsurgical treatment (Jensen et al. 2006; Landes et al. 2008; Niezen et al. 2018).

Considering the high prevalence of condylar fractures and the importance of treatment in the restoration of function, this study aimed to evaluate retrospectively the epidemiological characteristics of the prevalence, type and treatment modalities of the condylar mandibular fractures at two different centers. The tested hypothesis was that sociodemographic factors influence the features of the fractures.

2. Material and Methods

Data were collected retrospectively from patients who were seen at the Department of Oral and Maxillofacial Surgery of two Brazilian centers (Clinic Hospital of Uberlândia and Dom Luís Gonzaga Fernandes Trauma Emergency Hospital of Campina Grande) from 2009 to 2020. This study respected the principles of the Declaration of Helsinki (1.990.227) and was based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE Checklist) (von Elm et al. 2007). The sample size calculated considered 90% chance for detecting outcomes and level of significance at 5% was n=98 (Sealed Envelope Ltd. 2012).

Information was obtained from clinical notes and dental records of each patient using a standardized data collection form. The inclusion criteria were patients who presented the diagnosis of condyle fracture, treated by open reduction internal fixation or conservative treatment. The epidemiological survey excluded records with only mandibular fractures without involving the condylar region.

The variables investigated were age, gender, cause of fracture, fracture classification, other affected mandibular sites, type of treatment and postoperative complications.

The following categories of injury cause were considered: falls, road traffic accidents, assaults, sport injuries, work injuries, and other causes (Bonavolonta et al. 2017). Moreover, the fractures were classified according to their location in condylar head, condylar neck, or subcondylar (Neff et al. 2014).

The treatment modalities included surgical or nonsurgical treatment. Conservative therapy was divided into rigid maxillomandibular fixation, maxillomandibular fixation associated with elastic therapy, elastic therapy, physiotherapy, and follow-up.

Complications were also categorized into none, mouth opening limitation (less than 30mm), ankylosis, condylar degeneration (presence of sclerosis, condylar margin flattening, erosion of the cortical plate, subcortical cyst formation, osteophytes or calcified loose bodies in the soft tissues), unilateral mandibular deviation (disc displacement with reduction) (Ahmad et al. 2009), occlusal disorders, temporomandibular disorders, malocclusion, pain, and other complications.

Statistical analysis

The statistical analysis was performed using Excel (2016; Microsoft, Redmond, WA) and SigmaPlot software version 12.0 (Systat Software, Inc. Chicago, EUA). The chi-square test assessed the association between categorical variables such as treatment type and presence of complication, with $p < 0.05$.

3. Results

Our study evaluated 506 records, and 139 patients were diagnosed with mandibular condyle fractures, totaling 171 injuries (Figure 1). These data refer to 107 unilateral and 32 bilateral fractures. Most of the patients were males (85%) with an overall male: female ratio of 5.6:1. The highest occurrence of trauma was in the 21-30 years range (27.33%) followed by the 31-40 years range (25.17%) (Figure 2).

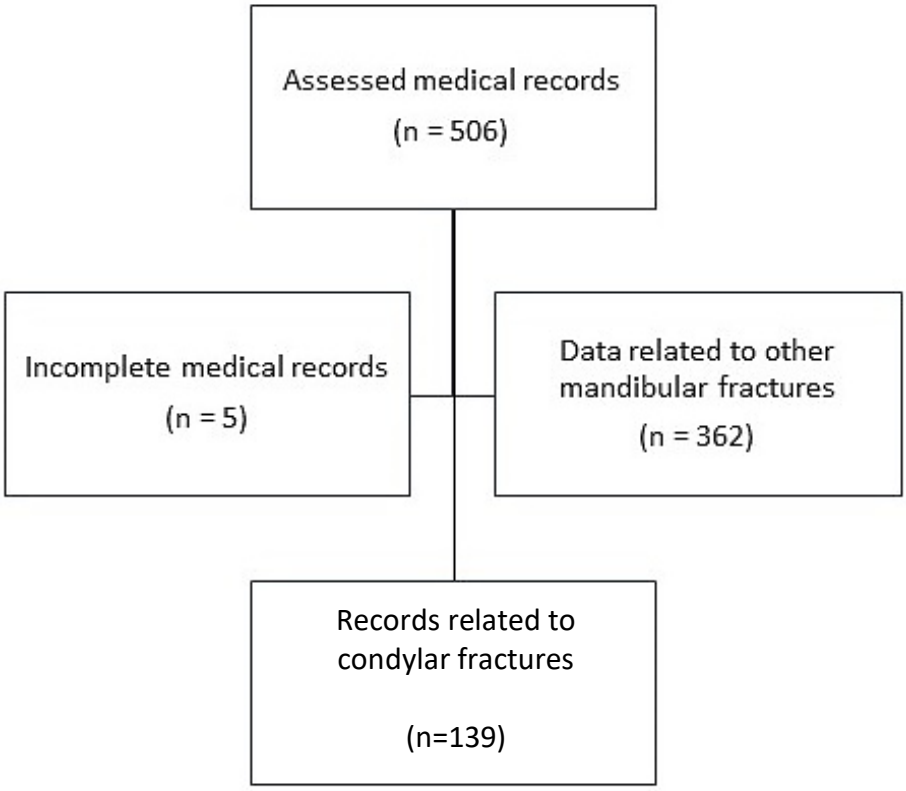

Figure 1. Flowchart of the medical records evaluated.

The most frequent etiology of fracture (Figure 3) was motorcycle traffic accidents (49%), followed by falls (13.66%), fight (13%), bicycle accidents (6.47%), car accidents (5.03%), sports accidents (3.6%), and others (5.03%).

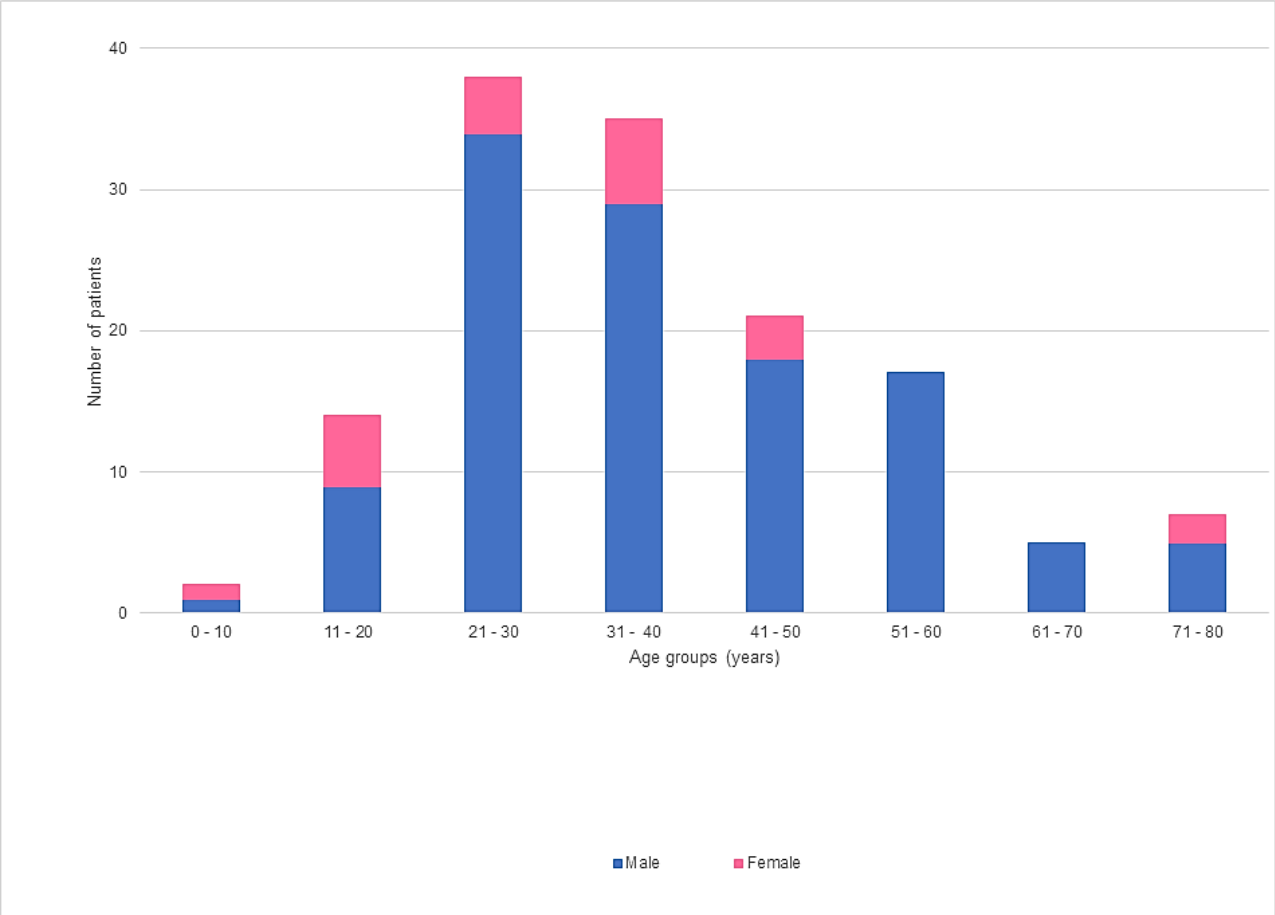

Figure 2. Distribution by age groups and gender.

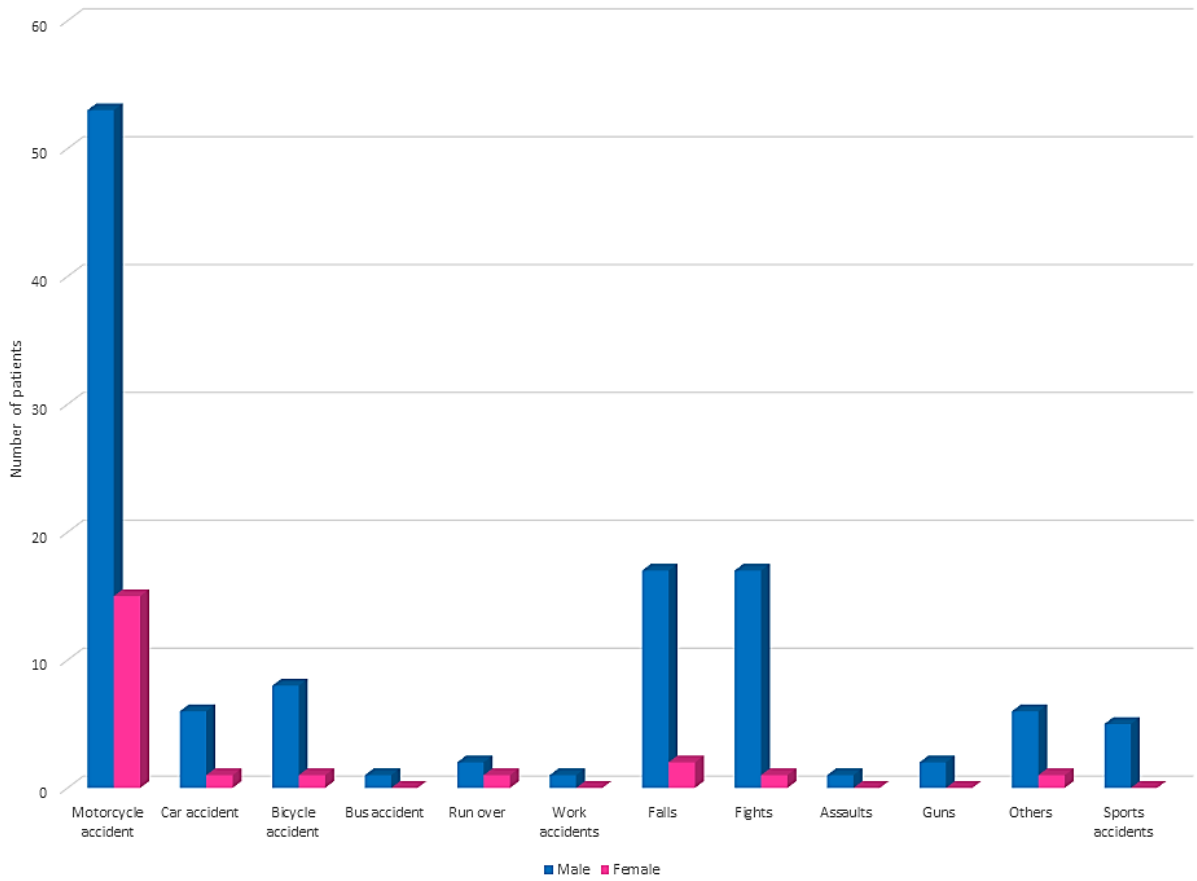

Figure 3. Distribution of etiologies in the study population.

Table 1 compares the types of condylar fractures associated with the treatment modalities (surgical and nonsurgical). There is a prevalence of subcondylar fractures with indication for surgical treatment. Moreover, the statistically significant difference between the kind of treatments is observed ($p < 0.001$).

Table 1. Comparison between fracture type and treatment modality (n=171).

	Head	Neck	Subcondylar
Nonsurgical	33 (19.3%) A	12 (7%) A	27 (15.8%) A
Surgical	3 (1.75%) B	14 (8.2%) B	82 (47.95%) B

Different letters represent statistically significant differences ($p < 0.05$, Chi-Square Test); upper-case letters compare treatments (lines).

Table 2 shows the different types of complications associated with treatment modalities. In the nonsurgical treatment group, the prevalence of complications was observed compared to the surgical group. This difference was statistically significant ($p < 0.001$). The predominant complications were: mouth opening limitation (28.4%), mandibular deviation (14.9%), malocclusion (13.5%), temporomandibular disorder (12.17%), pain (10.9%), paresthesia (6.75%), and facial paralysis (4.05%).

Table 2. Complications associated with different treatment modalities (n=74).

Complications	Surgical			Nonsurgical		
	Head	Neck	Subcondylar	Head	Neck	Subcondylar
Degeneration	-	-	1	-	-	-
Hearing Loss	-	-	-	1	-	-
Malocclusion	-	-	1	6	1	2
Mandibular Deviation	-	1	3	4	-	3
Mouth opening limitation	-	-	8	6	-	7
Pain	-	-	4	2	-	2
Paresthesia	-	-	5	-	-	-
Facial paralysis	-	-	3	-	-	-
Occlusal Disorders	-	-	-	4	-	-
Temporomandibular Disorders	-	-	4	2	-	3
Tinnitus	-	-	-	-	-	1
Total in each region	-	1	29	25	1	18
Overall		30			44*	

* Represents statistically significant difference between groups ($p < 0.05$), Chi-square test.

Symphysis fracture was the most common mandibular condyle injury (37 cases; 63.8%). Other affected regions were the mandibular body (15 cases; 25.7%), angle (three cases; 5.2%), ramus (two cases; 3.5%), and coronoid (one case; 1.8%) (Figure 4).

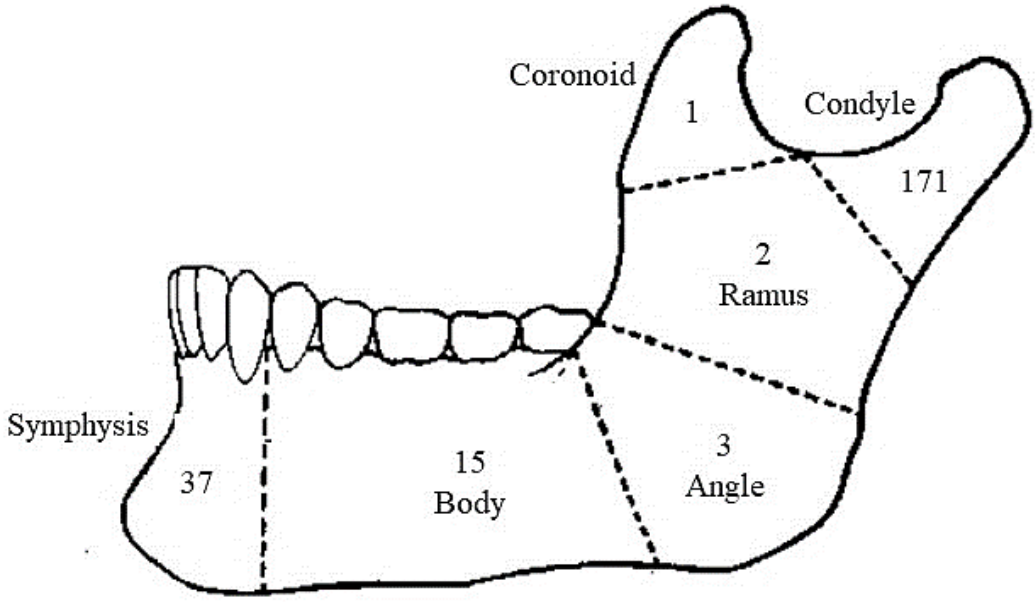

Figure 4. Anatomical distribution of fractures associated with region condylar.

4. Discussion

The hypothesis tested in this study was rejected. The patients reviewed were from institutions located in the northeast and southeast of Brazil. Although the two regions present many cultural differences, both have a high demographic density and homogeneous human development index (HDI) (IBGE 2022). This similarity also reflects on the epidemiological characteristics of condylar fractures, representing a public health problem (Amarista et al. 2017; Niezen et al. 2018).

In the present study, the male gender was the most affected (85%) compared with the female gender (15%). The male: female ratio was 5.6:1. The highly disproportionate rates between males and females are reported in several papers (Afrooz et al. 2015; Kruger and Tennant 2016) and explained by the increasing violence rates, negligence in traffic and exposure of men to risky activities (Patel et al. 2016; Moura et al. 2018). Another factor observed was the predominance of fracture in the 21-30 years of age group. The reason might be that in this period of life people are more actively engaged in high-speed transportation, fights, sporting, violent activities and industry (Verma and Chambers 2015; Chaurasia and Katheriya 2018). The lower prevalence in the very young and elderly age groups is due to family care, surveillance of children and characteristics of the elderly in developing activities with less impact. In these age groups trauma is usually simple fractures related to household accidents such as slipping, falling and child play (Montovani et al. 2006).

The etiology of maxillofacial trauma is an important epidemiological factor that directly affects the clinical presentation and treatment modalities of the facial fractures (Mijiti et al. 2014). The results showed that the main etiologic factor of the fractures were motorcycle traffic accidents. The higher risks of traffic accident with motorcycle drivers are due to a set of factors, among which the high acquisition rate of this type of vehicle, behavior in traffic and the lack of investment in road infrastructure stand out (Rios et al. 2019). For motorcyclists and cyclists, the helmet is the main safety measure that protects them in case of accidents (Munante-Cardenas et al. 2015). Another relevant factor is the recklessness related to alcohol consumption and non-compliance with traffic laws contributing to the increase of this index (Damacena et al. 2016).

The epidemiological analysis showed a prevalence of subcondylar fractures (63.75%). The force applied to the mandible is distributed, affects the weakest point in the mandibular arch, and causes extreme bending and tensile failure at that point. Subcondylar fractures are tension failures in response to bending of the mandibular neck. Because the mandible distributes the force of impact, fractures often occur in the subcondylar region (Sawazaki et al. 2010).

The classification systems of this macrotrauma allow for more effective clinical communication and support for decision making when formulating treatment plans (Mittermiller et al. 2019). When evaluating the treatment protocols associated with fracture levels, a statistically significant difference was observed between the therapies of choice ($p < 0.05$). Over half (57.9%) of the fractures were treated surgically. The prevalence in choosing this form of treatment may be associated with fracture characteristics. In this epidemiological study, 47.95% of the fractures were located at the base of the condyle. Correct anatomical position of the fragments has been achieved significantly more accurately in the open reduction internal fixation group in contrast to the closed treatment group (Zhang and Obeid 1991). Other indications for surgical treatment include displacement of the condyle to the middle cranial fossa, condylar displacement of more than 45º from the longitudinal axis in lateral or frontal projection, impossibility of obtaining adequate occlusion by conservative treatment and impairment by condylar fragment in mandibular mobility (Widmark et al. 1996). It is important to mention that 15.8% of the patients who had subcondylar fractures were treated conservatively. This type of treatment has been performed in cases where the patient has a stable occlusion after the trauma, presence of bilateral fracture, in children or patients that seek treatment belatedly.

The post-operative complications in the management of mandibular condylar fractures showed a statistically significant difference in the conservative treatment group compared to the surgical group ($p < 0.001$). While open reduction internal fixation can restore the most ideal anatomical position, the conservative treatment results in functional adaptation to the altered anatomy. During this period of adaptation there may be triggering comorbidities (Cabral et al. 2020). Other factors that may also contribute to the appearance of these changes are related to limited access to oral rehabilitation programs after treatment and the follow-up period. Most patients are symptom-free although some clinical findings of dysfunction are present, suggesting that all patients recover relatively well (Ferrer et al. 2019). This lack of symptomatology means that patients do not seek the service after treatment. Thus, a longer follow-up period could decrease the risk of irreversible changes.

The most common complaint after treatment was mouth opening limitation (28.4%). Two factors may be associated with this complication: first, a short period of assessment of mandibular mobility (up to 45 days) and the period of immobilization of the injured joint. Early mobilization of the mandible has been associated with better outcomes regarding mandibular movement (Blumer et al. 2019).

Another complication resulting from condylar fracture, in both treatments, was mandibular deviation (14.9%). However, the conservative group was most affected. Factors affecting midline deviation during maximum interincisal opening include damage to the temporomandibular joint, shortening of the ramus height, and loss of lateral pterygoid muscle function. Deflection and lateral shift of the mandible are often signs of compensatory movements of the contralateral joint due to shortening of the ramus height on the affected side. Since there is no repositioning of the condylar head in nonsurgical treatment, a greater lateral deviation is expected in the group (Chrcanovic 2015; Rastogi et al. 2015; Cabral et al. 2020).

Malocclusion was also reported (13.5%). The incidence of occlusal disturbance is attributed to the reduction in ramus height or to condyle dislocation from the fossa. In the long term, incomplete anatomical restoration with a remaining reduced ramus height in nonsurgical treatment may cause facial asymmetry and inclination of the occlusal plane, as well as functional occlusal problems, such as premature contact (Chrcanovic 2015). The presence of this morbidity is also related to a decrease in quality of life (Hakim et al. 2018).

Mandibular condylar fractures, in addition to increasing the risk in restricting mouth opening, may trigger pain, disc displacement or other temporomandibular disorders (Jensen et al. 2006). The latter was reported by 12.7% of patients. A systematic review showed a prevalence of myofascial pain of 6–12.9%, intra-articular joint disorders of 8.9–15.8%, and arthralgia diagnoses of 2.6% (Widmark et al. 1996). This indicates that the findings of this study are consistent with those in the general population with regard to prevalence rates (Palmieri et al. 1996).

Facial nerve damage and paresthesia of the mental nerve were observed in the surgical treatment with percentage 10.8%. The temporozygomatic division of the facial nerve has an intimate anatomic relationship with the condylar process. When approaching the condylar region from a retromandibular or preauricular approach, visualization of the facial nerve-condyle relationship is limited, and a moderately

strong retraction is frequently required to obtain an adequate visual field and working space for osteosynthesis. Although the temporozygomatic (upper) division of the facial nerve should not be encountered during the submandibular approaches, the nerve is retracted laterally and easily stretched when attempting to achieve an ample working space and optical field. The surgeon must appreciate that blind and aggressive lateral or superior retraction of overlying soft tissue in this region may easily result in stretch injury. Understanding this close relationship should help reduce the incidence of facial nerve injury during surgical treatment of the condylar region (Barham et al. 2015).

This epidemiological study showed other affected mandibular regions. Fifty-eight mandibular fractures were associated with condylar fractures. The symphysis was the most common injury site. These findings suggest that the mandibular fracture pattern (different locations) depends on the effect of an external force and the magnitude and direction of this force influence the mandibular fracture site (Zhou et al., 2016). Applying a higher external force to the symphysis region produces a condylar fracture by indirect impact (Sawazaki et al. 2010).

Limitations to this study are associated with clinical and radiographic evaluation immediately after the treatment of choice. Longitudinal studies analyzing mandibular motion after prolonged physiotherapy are required. However, the results do provide important information necessary for the development and evaluation of preventive measures aimed at reducing the frequency of condylar injuries, mainly due to road traffic accidents in Brazil, where the incidence is increasing annually.

5. Conclusions

Within the limitations of this study, it can be concluded that fracture of the subcondylar region is the most frequent, especially in males aged 21-30 years. Also, the surgical treatment approach showed fewer complications when compared to the other treatments.

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